INTERFACE CONTROL REQUIREMENTS

SAN MATEO COUNTY SMART CORRIDORS PROGRAM

FOR

SMCTA / CALTRANS / C/CAG

Prepared by:

URS

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1.0 Introduction and Background

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The City/County Association of Governments of San Mateo County (C/CAG) and the San Mateo County Transportation Authority (SMCTA) in conjunction with the California Department of Transportation (Caltrans) has initiated an effort to address the operation of the freeway and arterial roadway network in San Mateo County. The San Mateo County Smart Corridor Program is intended to benefit a variety of users including commuters, local traffic, and commercial vehicle and transit operators.

The mitigation of the impacts of non-recurring traffic congestion on local streets within San Mateo County during major freeway incidents on US-101 was identified as a high-priority project in the Smart Corridor Program. A Project Report (PR) was written that proposes the deployment of integrated Intelligent Transportation System (ITS) elements to provide local agencies and Caltrans the tools to manage this congestion. The project includes the installation of the following ITS elements:

- Directional signs (trailblazer and turn prohibition) to direct traffic;
- Fixed or pan-tilt-zoom closed-circuit television cameras at intersections and midblock locations to monitor traffic congestion and end-of-queue location;
- Communications to provide interconnect between local agency traffic signals on local streets and State operated traffic signals on State routes;
- Upgraded traffic signal controllers and/or cabinets and signal operation software systems;
- Arterial changeable message signs to inform motorists of traffic conditions (also referred to as Arterial Dynamic Message Signs in this document);
- Center-to-center communications between the proposed San Mateo County Hub (SMCHub) and the Caltrans District 4 Transportation Management Center (D4TMC) (note where TMC is used in a general manner in this document, it refers to the SMCHub, the D4TMC and local TMCs);
- Vehicle detector stations (non-intrusive or intrusive technology) on non-freeway state routes (El Camino Real) and local streets at mid-block locations.

Many of these same elements can also be used to manage traffic along the corridor during recurrent congestion. In addition to the ITS elements noted above, the following ITS elements were identified for possible deployment on future projects:

- Transit priority service at intersections;
- Emergency vehicle preemption at intersections;
- Highway Advisory Radio (HAR) transmitters and signs;
- Advance warning signs at Caltrain at-grade crossings;
- Changeable message signs for arterial travel times.

A Concept of Operations (ConOps) was prepared in October 2008, with input from local agencies and Caltrans, and direction from the Federal Highway Administration (FHWA). This is an initial step in the Systems Engineering process defined by the FHWA. This

document identifies the stakeholders, their roles and responsibilities, their coordination with each other, and how the system will be developed.

1.2 Relevant Documents

Relevant documents include:

- FHWA/Caltrans Systems Engineering Guidebook for ITS, version 2.0, January 2007
- Final Draft ITS Infrastructure Improvement Plan, San Mateo County Alternative Route Plan, January 2008
- Draft Project Report in San Mateo County on US-101 and SR-82 from I-380 to the Santa Clara County Line, San Mateo County Smart Corridors, EA 4A9200, October 2008
- Project Study Report to Request Programming in the STIP for Phase 1of the San Mateo County Smart Corridors, March 2008
- San Mateo County Smart Corridors Projects Traffic Light Synchronization Program Funding Application March 2008
- San Mateo County Arterial Route for Traffic Incident Guide, February 2009
- San Mateo County Smart Corridors Program Concept of Operations, October 2008
- System Engineering Management Plan, San Mateo County Smart Corridors Program, version 10000.004, September 2009
- Functional Requirements, San Mateo County Smart Corridors Program, version 12000.007, September 2009
- High-Level Requirements, San Mateo County Smart Corridors Program, version 13000.003, September 2009
- Detailed Design Requirements, San Mateo County Smart Corridors Program, version 13500.004, September 2009

Definitions and acronyms in this document are defined in the System Engineering Management Plan noted above.

2.0 Scope of Project

The goals of the project identified in the Concept of Operations have been modified as shown in **Table 1**.

Table 1 – Project Goals

Goal Area	Smart Corridors Program Goals
Traffic Incident Management	• Proactively manage traffic already diverted from the freeway to minimize impacts on local arterials, and return regional traffic back to the freeway as soon as possible by: o Actively managing traffic signal operations on selected routes to maximize traffic flow around a major incident and minimize delays caused by diverted freeway traffic. o Improving collection of current travel condition information along local arterials on the alternate routes.

Goal Area	Smart Corridors Program Goals
	(Future) o Providing accurate and timely route guidance information about the corridors to agency transportation managers. (Future) o Minimizing the intrusion of freeway traffic on local streets due to major freeway incidents.
Interagency Coordination	• Provide the capability for shared control and operation of the Smart Corridors components by the agencies. • Improve sharing of resources between agencies for more unified transportation management operations across jurisdictions. • Improve communications between the agencies during major freeway incidents.
Traffic Operations and Management	• Improve traffic flow within the corridor during normal operation • Share traffic information between the agencies to improve coordination and management of traffic during normal operations

3.0 Purpose of Document

3.1 Provide high level requirements for the interfaces between the individual field devices and the central subsystem; between different subsystems and between traffic management centers.

3.2 Reduce the cost of the design of the System by minimizing omissions, misunderstandings and inconsistencies early in the design cycle.

3.3 Provide a basis of understanding among the system designers and other stakeholders.

3.4 Provide input to the San Francisco Bay Area Regional Architecture.

4.0 Requirements

4.1 Communications Subsystem -- General

The following are major communications interface standards and guidelines that are typically used in ITS and advanced traffic signal control applications that are currently published by the various standards development organizations. This list is not an exhaustive list, but was developed by mapping the near-term deployment plans for the San Mateo Smart Corridor with available (published) standards.

National Transportation Communications for ITS Protocol (NTCIP) is the main industry standard that defines the communication protocol between ITS field elements and the Transportation Management Center, as well as between Transportation Management Centers.

NTCIP is not a single standard but a collection of standards that define rules for communicating over a network (called protocols) and provide the vocabulary (called objects) necessary to allow field elements from different manufacturers to operate as a system. Also defined are message sets and data dictionaries. Message sets work in conjunction with data dictionaries that provide the definition and syntax of individual objects to make up the specific message content of a message. In a simple analogy,

message sets are the sentences that contain objects as the individual words. The other standards needed for data exchange provide the actual communications protocols that describe how messages are encoded for transmission, transmitted and then decoded by the receiver.

To facilitate implementation, the standards group objects by function. For a specific function, the NTCIP standards further group the objects into mandatory and optional groups. Mandatory object groups are required to be implemented to provide a minimum level of operation. Optional object groups are chosen by the designer to accomplish specific functionality.

The designers shall use only published standards with any amendments only as approved by Caltrans. During the detailed design stage, the designer must define both the protocols and object groups to be implemented for a specific project as well as determine the series of protocols to be used for message transmission (i.e. protocol stack). In specific situations where either optional or mandatory object groups provide the needed functionality, the designer could specify proprietary objects developed by the equipment manufacturer. When proprietary objects are used, the designer must ensure the copyrights are granted to the local agency for future use and disclosure of the objects.

For detailed information on the standards and guides listed below the reader is referred to the following documents and information:

- NTCIP Guide - NTCIP 9001 (Ver. 03.02 Published October 2002): www.ntcip.org
- Traffic Management Data Dictionary (TMDD) Guide (Ver. 3.0 Published November 20, 2008): http://www.ite.org/standards/tmdd/
- ITS Standards Fact Sheets: www.standards.its.dot.gov/factsheets.asp

4.2 Communications Subsystem – Center-to-Center (C2C)

The following standards shall be followed to implement the communication protocols between the D4TMC and the SMCHub, the SMCHub and the Local Agency Traffic Signal Systems and SMCHub and other future TMCs:

4.2.1 San Francisco Bay Area Regional Architecture

4.2.2 San Francisco Bay Area C2C Interface Control Document (ICD)

4.2.3 Coordinate with Caltrans in regards to the following NTCIP C2C standards:

4.2.3.1 NTCIP C2C: NTCIP Center-to-Center Standards Group

4.2.3.2 ITE TMDD: International Transportation Engineers (ITE)Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications (MS/ETMCC) (Ver. 3.0 Published 2008)

4.2.3.3 ITE TMDD Guide: TMDD & MS/ETMCC Guide Standard for Functional Level Traffic Management Data Dictionary

(TMDD) and Message Sets for External Traffic Management Center Communications (Ver. 2.1 Published 2006)

4.2.3.4 Center-to-Center Naming Convention Specification NTCIP 1104 (Ver. 1.0 Published 2008)

4.2.3.5 Application Profile for Extensible Markup Language (XML) Message Encoding and Transport in ITS Center-to-Center Communications (AP-C2CXML) NTCIP 2306 (Ver. 1.0 Published 2008)

4.2.3.6 XML in ITS Center-to-Center Communications NTCIP 9010 (Ver. 1.0 Published 2006)

4.2.4 Standard for Common Incident Management Message Sets for use by Emergency Management Centers IEEE 1512-2006 (Ver. 2.0 Published 2006)

4.2.5 Standard for Traffic Incident Management Message Sets for Use by Emergency Management Centers IEEE 1512.1-2006 (Ver. Published 2006)

4.3 Communications Subsystem -- Center-to-Field (C2F)

4.3.1 The following general standards as well as the other standards indicated within this ICD as applicable shall be followed to implement the communication between the TMC and field elements:

4.3.1.1 Caltrans Transportation Electrical Equipment Specifications (TEES), dated March 2009: for physical communications interface requirements, as applicable

4.3.1.2 Simple Transportation Management Framework (STMF) NTCIP 1101 (Ver. 1.0 Published 1999)

4.3.1.3 Octet Encoding Rules (OER) Base Protocol NTCIP 1102 (Ver. 1.0 Published 2006)

4.3.1.4 Transportation Management Protocols (TMP) NTCIP 1103 (Ver. 1.0 Published 2009)

4.3.1.5 Global Object Definitions NTCIP 1201 (Ver. 1.0 Published 1996)

4.3.1.6 Object Definitions for Signal Control and Prioritization (SCP) NTCIP 1211 (Ver. 1.0 Published 2008)

4.3.1.7 Ethernet Sub-network Profile NTCIP 2104 (Ver. 1.0 Published 2006)

4.3.1.8 Transportation Transport Profile NTCIP 2201 (Ver. 1.0 Published 2006)

4.3.1.9 Internet (Transmission Control Protocol (TCP)/ Internet Protocol (IP) and User Datagram Protocol (UDP) /IP) Transport Profile NTCIP 2202 (Ver. 1.0 Published 2001)

4.3.1.10 Simple Transportation Management Framework (STMF) Application Profile NTCIP 2301 (Ver. 1.0 Published 2001)

4.3.2 The following general standards shall be followed to implement the communication between the TMC and legacy field devices:

4.3.2.1 Octet Encoding Rules (OER) Base Protocol NTCIP 1102 (Ver. 1.0 Published 2006)

4.3.2.2 Transportation Management Protocols (TMP) NTCIP 1103 (Ver. 1.0 Published 2009)

4.3.2.3 Point-to-Multi-Point Protocol (PMPP) using RS-232 Sub-network Profile NTCIP 2101 (Ver. 1.0 Published 2001)

4.3.2.4 Point-to-Multi-Point Protocol (PMPP) using FSK Modem Sub-network Profile NTCIP 2102 (Ver. 1.0 Published 2006)

4.3.2.5 Point-to-Point Protocol (PPP) over RS-232 Sub-network Profile NTCIP 2103 (Ver. 2.0 Published 2008)

4.3.2.6 Simple Transportation Management Framework (STMF) Application Profile NTCIP 2301 (Ver. 1.0 Published 2001)

4.3.2.7 Trivial File Transfer Protocol (TFTP) Application Profile NTCIP 2302 (Ver. 1.0 Published 2001)

4.3.2.8 NEMA Standards Publication TS 2-2003 v02.06 Traffic Controller Assemblies with NTCIP Requirements (this standard includes requirements for compatibility with older NEMA TS-1 standards)

4.3.2.9 Assembly Bill 3418E (in case of conflict, this requirement shall override all other requirements)

4.3.3 The following standards shall be followed to implement the communication between the TMC and a traffic signal controller:

4.3.3.1 NTCIP C2F: NTCIP Center-to-Field Standards Group

4.3.3.2 Global Object Definitions NTCIP 1201 (Ver. 1.0 Published 1996)

4.3.3.3 Object Definitions for Actuated Traffic Signal Controller (ASC) Units NTCIP 1202 (Ver. 1.0 Published 1996)

4.3.3.4 Object Definitions for Signal Control and Prioritization (SCP) NTCIP 1211 (Ver. 1.0 Published 2008)

4.3.3.5 Advanced Transportation Controller (ATC) Family of Standards: Application Program Interface (API), Controller, Cabinet, as applicable

4.3.3.6 AB 3418E (in case of conflict, this requirement shall override all other requirements)

4.3.4 The following standards shall be followed to implement the communication between the TMC and the CCTV Camera Subsystem:

4.3.4.1 NTCIP C2F: NTCIP Center-to-Field Standards Group

4.3.4.2 Global Object Definitions NTCIP 1201 (Ver. 1.0 Published 1996)

4.3.4.3 Object Definitions for Closed Circuit Television (CCTV) Camera Control NTCIP 1205 (Ver. 1.0 Published 2001)

4.3.4.4 Object Definitions for Closed Circuit Television (CCTV) Switching NTCIP 1208 (Ver. 1.0 Published 2005)

4.3.5 The following standards shall be followed to implement the communication between the TMC and arterial dynamic message signs (ADMS) and other directional signs:

4.3.5.1 Caltrans (TEES) Chapter 8 CMS, dated June 2009: for physical communications interface requirements, as applicable

4.3.5.2 NTCIP C2F: NTCIP Center-to-Field Standards Group

4.3.5.3 Global Object Definitions NTCIP 1201 (Ver. 1.0 Published 1996)

4.3.5.4 Object Definitions for Dynamic Message Signs (DMS) NTCIP 1203 (Ver. 2.35 Recommended Standard March 2007)

4.3.5.5 Sub-network Profile (SP)-PMPP/RS232 NTCIP 2101 (Ver. 1.0 Published 2001)

4.3.5.6 SP-PMPP/RS232 NTCIP 2103 (Ver. 2.0 Published 2008)

4.3.5.7 Transportation Transport Profile NTCIP 2201 (Ver. 1.0 Published 2006)

4.3.5.8 NTCIP Application Profile (AP)-STMF NTCIP 2301 (Ver. 1.0 Published 2001)

4.3.6 The following standards shall be followed to implement the communication between the TMC and the vehicle detection system:

4.3.6.1 NTCIP C2F: NTCIP Center-to-Field Standards Group

4.3.6.2 Global Object Definitions NTCIP 1201

4.3.6.3 Coordinate with Caltrans in regards to the implementation of Object Definitions and Data Element Definitions for vehicle detection systems

4.3.7 Location Referencing

4.3.7.1 The Location Referencing Message Specification shall be common throughout the System.

4.3.7.2 If multiple profiles are used, a translator shall be used to provide a common reference.

4.3.8 Connections

4.3.8.1 The communications backbone shall provide a high-speed connection with a bandwidth suitable for handling all devices simultaneously.

4.3.8.2 Connections to remote devices may be high-speed or low-speed depending on the device and its data requirements.

4.3.8.3 Device interfaces shall support high-speed or low-speed connections as applicable to a specific device.

4.3.9 Security

4.3.9.1 The communications network shall provide system security by the use of a firewall or firewall router.

4.3.9.2 Password encryption shall be used.